

WHAT IS CLAIMED IS:

1. A process for the synthesis of a mesoporous aluminum oxide composition,  
comprising:

dissolving at least one organic aluminum source in at least one solvent to form a  
5 mixture;

adding at least one pore-forming agent to the mixture;

adding a solvent to the mixture;

drying the mixture at a temperature ranging from about 40°C to about 140°C for  
a period of time ranging from about 2 to about 48 hours to obtain a dried gel; and,

10 removing the pore-forming agent from the dried gel.

2. The process of claim 1 wherein the aluminum source comprises aluminum  
alkoxides or aluminum organic salts.

15 3. The process of claim 1 wherein the solvent is selected from the group  
consisting of water, alcohols, ethers, esters, ketones and mixtures of one or more thereof.

4. The process of claim 1 wherein said pore-forming agent comprises an organic  
compound having a boiling point higher than 180°C.

20 5. The process of claim 4 wherein the said pore-forming agent comprises an  
organic compound having at least one heteroatom selected from N, O and S.

6. The process of claim 5 wherein the said pore-forming agent is selected from the group consisting of tetraethylene glycol, triethanolamine, triisopropanolamine, triethylene glycol, diethylene glycol, sulfolane, and diethylglycoldibenzonate.

5           7. The process of claim 1 wherein a molar ratio of the pore-forming agent to aluminum in the aluminum source is from about 0.1 to about 2.0.

8. The process of claim 1 wherein the at least one organic aluminum source is mixed with a framework substituted element selected from the group consisting of Si, Ga,  
10       B, P, S, La, Ce, Ti, Fe, Ni, Mo, Co, Cr, Mg, Zn, Sn, V, W, Ru, Pt, Pd, In, Mn and Cu.

9. The process of claim 1 further comprising ageing the mixture at a temperature ranging from about 10°C to about 90°C for a period of time ranging from about 0 to about 48 hours prior to drying the mixture.

15           10. The process of claim 1 further comprising heating the dried gel in an autoclave at a temperature ranging from about 80°C to about 200°C for a period of time ranging from about 0 to about 96 hours subsequent to drying the mixture.

20           11. A process for the synthesis of a mesoporous aluminum oxide composition, comprising:

dissolving at least one inorganic aluminum source in a solvent to obtain a mixture;  
adding at least one pore-forming agent to the mixture;  
adding at least one alkali to the mixture;  
5 drying the mixture at a temperature ranging from about 40°C to about 140°C for a period of time ranging from about 1 to about 48 hours to obtain a dried gel; and,  
removing the pore-forming agent from the dried gel to obtain a powder.

12. The process of claim 11 wherein the at least one inorganic aluminum source  
10 is selected from the group consisting of aluminum nitrate, aluminum chloride, aluminum sulfate, aluminum perchlorate and aluminum acetate.

13. The process of claim 11 wherein the solvent is selected from the group consisting of water, alcohols, ethers, esters, ketones and mixtures of one or more thereof.

15 14. The process of claim 11 wherein said pore-forming agent comprises an organic compound having a boiling point higher than 180°C.

20 15. The process of claim 14 wherein the said pore-forming agent comprises an organic compound having at least one heteroatom selected from N, O and S.

16. The process of claim 15 wherein the said pore-forming agent is selected from the group consisting of tetraethylene glycol, triethanolamine, triisopropanolamine, triethylene glycol, diethylene glycol, sulfolane, and diethylglycoldibenzonate.

5            17. The process of claim 11 wherein a molar ratio of the pore-forming agent to aluminum in the aluminum source is from about 0.1 to about 2.0.

18. The process of claim 11 wherein the at least one alkali is selected from the group consisting of inorganic and organic alkalis.

10            19. The process of claim 18 wherein the inorganic alkali is selected from the group consisting of sodium hydroxide, sodium carbonate, ammonia, ammonium hydroxide and ammonium carbonate.

15            20. The process of claim 18 wherein the organic alkali is selected from the group consisting of tetra alkyl ammonium hydroxides, tetra alkyl ammonium halides, tetra alkyl ammonium nitrates, unsubstituted urea and substituted ureas.

20            21. The process of claim 11 wherein the at least one inorganic aluminum source is mixed with a framework substituted element selected from the group consisting of Si, Ga, B, P, S, La, Ce, Ti, Fe, Ni, Mo, Co, Cr, Mg, Zn, Sn, V, W and Cu.

22. The process of claim 11 further comprising ageing the mixture at a temperature ranging from about 10°C to about 80°C for a period of time ranging up to about 96 hours prior to drying the mixture.

5           23. The process of claim 11 further comprising heating the dried gel in an autoclave at a temperature ranging from about 80°C to about 200°C for a period of time ranging up to about 96 hours subsequent to drying the mixture.

10           24. The process of claim 11 further comprising washing the powder with water to remove salts generated during the preparation subsequent to removing pore-forming agent.

15           25. The process of claim 11 further comprising drying the powder after washing with water to remove salts.

20           26. A process for adjusting mesopore sizes in mesoporous aluminum oxides, comprising:

          preparing a mixture comprising at least one aluminum species and at least one pore-forming agent;

          drying the mixture at a temperature ranging from about 40°C to about 140°C for a period of time ranging from about 1 to about 48 hours to obtain a dried gel;

heating the dried gel in an autoclave at a temperature ranging from about 80°C to about 200°C for a period of time ranging from about 1 to about 120 hours; and, removing the pore-forming agent.

5           27. The process of claim 26 wherein said pore-forming agent comprises an organic compound having a boiling point higher than 180°C.

28. The process of claim 27 wherein the said pore-forming agent comprises an organic compound having at least one heteroatom selected from N, O and S.

10           29. The process of claim 28 wherein the said pore-forming agent is selected from the group consisting of tetraethylene glycol, triethanolamine, triisopropanolamine, triethylene glycol, diethylene glycol, sulfolane, and diethylglycoldibenzonate.

15           30. A mesoporous aluminum oxide composition comprising one X-ray diffraction peak where  $2\theta$  is between about 0.3° to about 3.5°, wherein mesopores in said composition range from about 1.5 nm to about 20 nm in diameter and the said mesopores randomly interconnected, have a peak width at half height less than about 12 nm in a pore diameter distribution plot and have a pore volume ranging from about 0.3 to about 2.5  
20           cm<sup>3</sup>/g.

31. The composition of claim 30 wherein the composition includes a framework substituted element selected from the group consisting of Si, Ga, B, P, S, La, Ce, Ti, Fe, Ni, Mo, Co, Cr, Mg, Zn, Sn, V, W and Cu.

5            32. The composition of claim 31 wherein the molar ratio of framework substituted element to Al ranges from about 0.001 to 0.6.

33. The composition of claim 30 wherein the composition contains both four- and six-coordinated aluminum.

10           34. The composition of claim 30 wherein the composition contains four-, five- and six-coordinated aluminum.

15           35. The composition of claim 34 wherein the five-coordinated aluminum is less than about 30% of total aluminum in the composition.

36. The composition of claim 30 having an X-ray diffraction pattern with at least one reflection corresponding to a basal spacing ranging from about 2.5 nm to about 30.0 nm.

37. The composition of claim 30 wherein the composition has a N<sub>2</sub> or Ar adsorption-desorption isotherm with a step at P/P<sub>0</sub> between about 0.2 and about 0.9 and at least one hysteresis loop.

5                    38. The composition of claim 30 wherein the composition has a specific surface area ranging from about 180 to about 900 m<sup>2</sup>/g.

39. A process for treating organic compounds which comprises:

10                    a) providing a mesoporous aluminum oxide comprising one X-ray diffraction peak where 2θ is between about 0.3° to about 3.5°, wherein mesopores in said composition range from about 1.5 nm to about 20 nm in diameter and the said mesopores randomly interconnected, and have a pore volume ranging from about 0.3 cm<sup>3</sup>/g to about 2.5 cm<sup>3</sup>/g, wherein the mesoporous structure has optionally incorporated therewith at least about 0.02% by weight of at least one catalytically and/or chemically active  
15                    heteroatom selected from the group consisting of Si, Ti, V, Cr, Zn, Fe, Sn, Mo, Ga, Ni, Co, In, Zr, Mn, Cu, Mg, Pd, Ru, Pt, W and combinations thereof or zeolites;

20                    b) contacting feed under reaction conditions with said catalyst wherein the treating process is selected from the group consisting of catalytic reforming, steam reforming, fluid catalytic cracking, hydrotreating, CCR reduction, RCR reduction, isomerization, hydration, dehydration, hydrogenation, dehydrogenation, denitrogenation, demetallation, desulfurization, sulfur recovery including the Claus process, Fischer-Tropsch synthesis, ammoxidation, amination, Diels-Alder synthesis and adsorption.



40. The process of claim 39 wherein the treating process is catalytic reforming of naphtha, the feed comprises at least one hydrocarbon of the gasoline boiling range, and operating conditions comprise a pressure of from about 1 bar to 60 bars, a liquid hourly space velocity of from about 0.2 to 20 hr<sup>-1</sup>, and an operating temperature of from about 350° to 560°C.

41. The process of claim 39 wherein the treating process is steam reforming, the feed comprises at least one hydrocarbon, and an operating temperature of from about 700° to 1200°C.

42. The process of claim 39 wherein the treating process is Fischer-Tropsch synthesis, the feed comprises at least carbon monoxide and hydrogen, and operating conditions comprise a pressure of from about 3 bars to about 60 bars, and an operating temperature of from about 190°C to about 400°C.

43. The process of claim 39 wherein the treating process is dehydration, the feed comprises at least one alcohol, and operating conditions comprise a pressure of from about 0.1 bar to 10 bar, and an operating temperature of from about 100°C to about 300°C for liquid phase dehydration and 210°C to about 330°C for gas phase dehydration.

44. The process of claim 39 wherein the treating process is hydrocracking, the feed comprises at least one hydrocarbon, and operating conditions comprise a pressure of

from about 40 bars to 200 bars, a liquid hourly space velocity of from about 0.2 hr<sup>-1</sup> to about 6 hr<sup>-1</sup>, an operating temperature of from about 250°C to 550°C, and a hydrogen/hydrocarbon volume ratio of from about 200 to about 1000.

5            45. The process of claim 39 wherein the treating process is hydrotreating, the feed comprises at least one hydrocarbon, and operating conditions comprise a pressure of from about 3 bars to 240 bars, a liquid hourly space velocity of from about 0.05 hr<sup>-1</sup> to 25 hr<sup>-1</sup>, and an operating temperature of from about 200°C to 700°C.

10           46. The process of claim 39 wherein the treating process is amination, the feed comprises at least one hydrocarbon and one amination agent, and operating conditions comprise a pressure of from about 5 bars to about 50 bars, a liquid hourly space velocity of from about 0.01 hr<sup>-1</sup> to 2 hr<sup>-1</sup>, an operating temperature of from about 300° to 550°C, and an amination agent/hydrocarbon molar ratio of from about 1 to about 40.

15           47. The process of claim 39 wherein the treating process is hydrogenation, the feed comprises at least one unsaturated hydrocarbon, and operating conditions comprise a pressure of from about 5 bars to 120 bars, a liquid hourly space velocity of from about 1000 hr<sup>-1</sup> to about 30,000 hr<sup>-1</sup>, and an operating temperature of from about 25°C to 300°C.